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Double-balloon Remodeling for Coil Embolization of a Primitive Trigeminal Artery Variant Aneurysm

A Case Report

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Summary

Here we describe the case of a patient with a wide-necked unruptured aneurysm arising at origin of a persistent primitive trigeminal artery (PTA) variant from the right internal carotid artery (ICA), supplying the territory of the right superior cerebellar artery and the anterior inferior cerebellar artery. To preserve the ICA and the PTA variant, coil embolization of the aneurysm was performed using a double-balloon remodeling technique (HyperForm™ and HyperGlide™ Occlusion Balloon Systems; ev3 Endovascular Inc., Irvine, CA, USA). The association of a PTA variant with an aneurysm is very rare. To our knowledge, this is the first description of the use of coil embolization using double-balloon remodeling to treat a PTA variant aneurysm. This technique permits complete embolization and reduces the risk of cerebral and cerebellar ischemia.

Introduction

The persistent primitive trigeminal artery (PTA) is the most common primitive carotid-basilar anastomosis to occur during embryological development of the intracranial vasculature. The incidence of PTA has been reported to be between 0.1% and 0.6% on the basis of conventional angiography and magnetic resonance angiography (MRA) findings [1-7]. The PTA variant, regarded as a cerebellar artery arising from the precavernous internal carotid artery (ICA) with no connection with the basilar artery (BA), has a reported incidence between 0.2% and 0.76% [5,6,8].

PTA is associated with 25% intracranial vascular anomalies such as aneurysms (13.8%) [9] and arteriovenous malformations (4.5%) [3]. The PTA variant as well as the PTA may be associated with intracranial aneurysms (4.0%-26%) [4,10]. To date, only six cases of treated PTA variant cerebral aneurysms have been documented [11-16].

Endovascular coil embolization is one of the treatment options for PTA variant aneurysms. It is important to preserve the flow to the parent artery because the PTA variant supplies important regions that are not supplied by the vertebral and basilar arteries. Furthermore, perforating arteries from the PTA variant are important in supplying the hindbrain [17-20].

We describe a case of an unruptured broad-necked PTA variant aneurysm treated with coil embolization using a double-balloon remodeling technique to preserve both the internal carotid artery (ICA) and the PTA variant.

Case Report

A 62-year-old woman suffered from chronic headaches not trigeminal neuralgia, and screening MRA revealed an unruptured right ICA aneurysm at the cavernous segment (Figure 1). The aneurysm was considered an extradural aneurysm. She was subsequently referred to

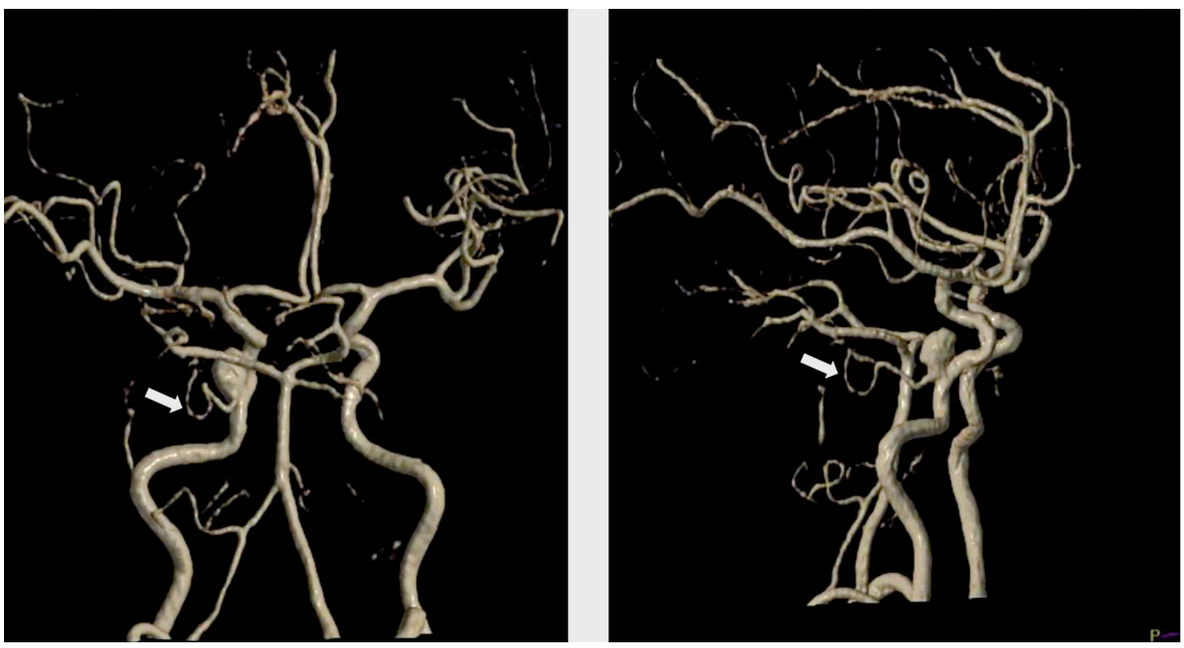

Figure 1 Anteroposterior (A) and oblique lateral (B) magnetic resonance angiography views revealing the 8.2 mm right cavernous internal carotid artery aneurysm and the anomalous anastomotic vessel from the aneurysm neck (arrow) not connected to the basilar artery.

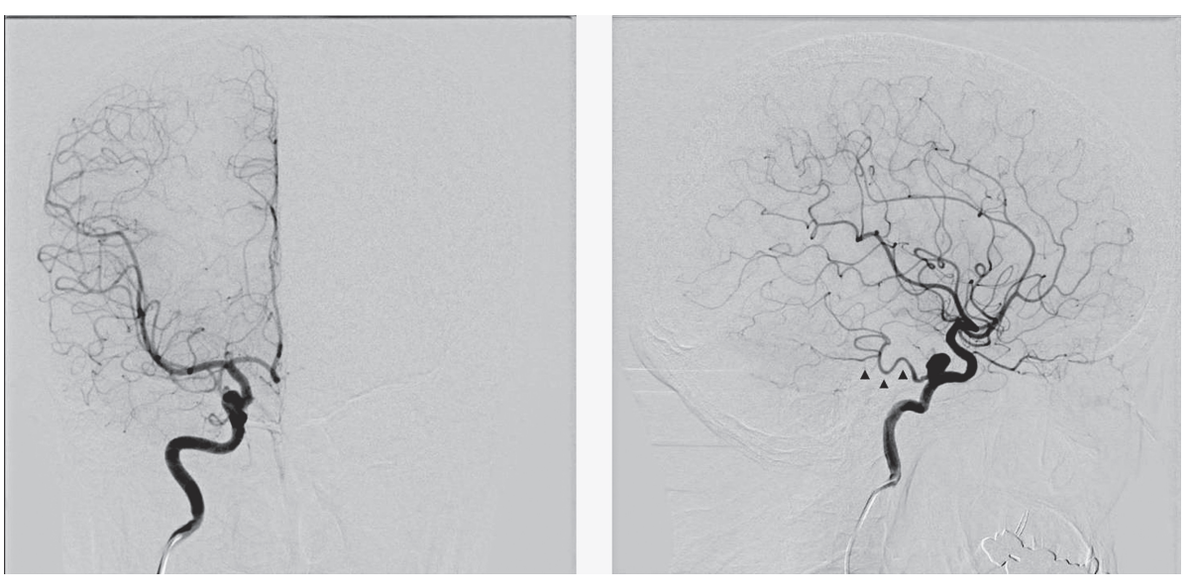

Figure 2 Right internal carotid angiograms [anteroposterior (A) and lateral (B) views] revealing that the right persistent primitive trigeminal artery (PTA) variant supplies the ipsilateral superior cerebellar artery and anterior inferior cerebellar artery region (arrowheads) as well as a saccular aneurysm. The PTA variant arises from the neck of the aneurysm.

our institution because she strongly hoped for endovascular treatment to avoid the risk of fetal nasal bleeding, direct carotid cavernous fistula, acute epidural hematoma, lower cranial nerve palsy, or neuralgia. Right carotid angiography revealed a saccular aneurysm (8.2 × 6.5 × 6.2 mm) at the cavernous portion of the right ICA. This aneurysm originated from the junction of the PTA variant, which anastomosed the precavernous portion of the right ICA to the common trunk of the right superior cerebellar artery (SCA) and anterior inferior cere-

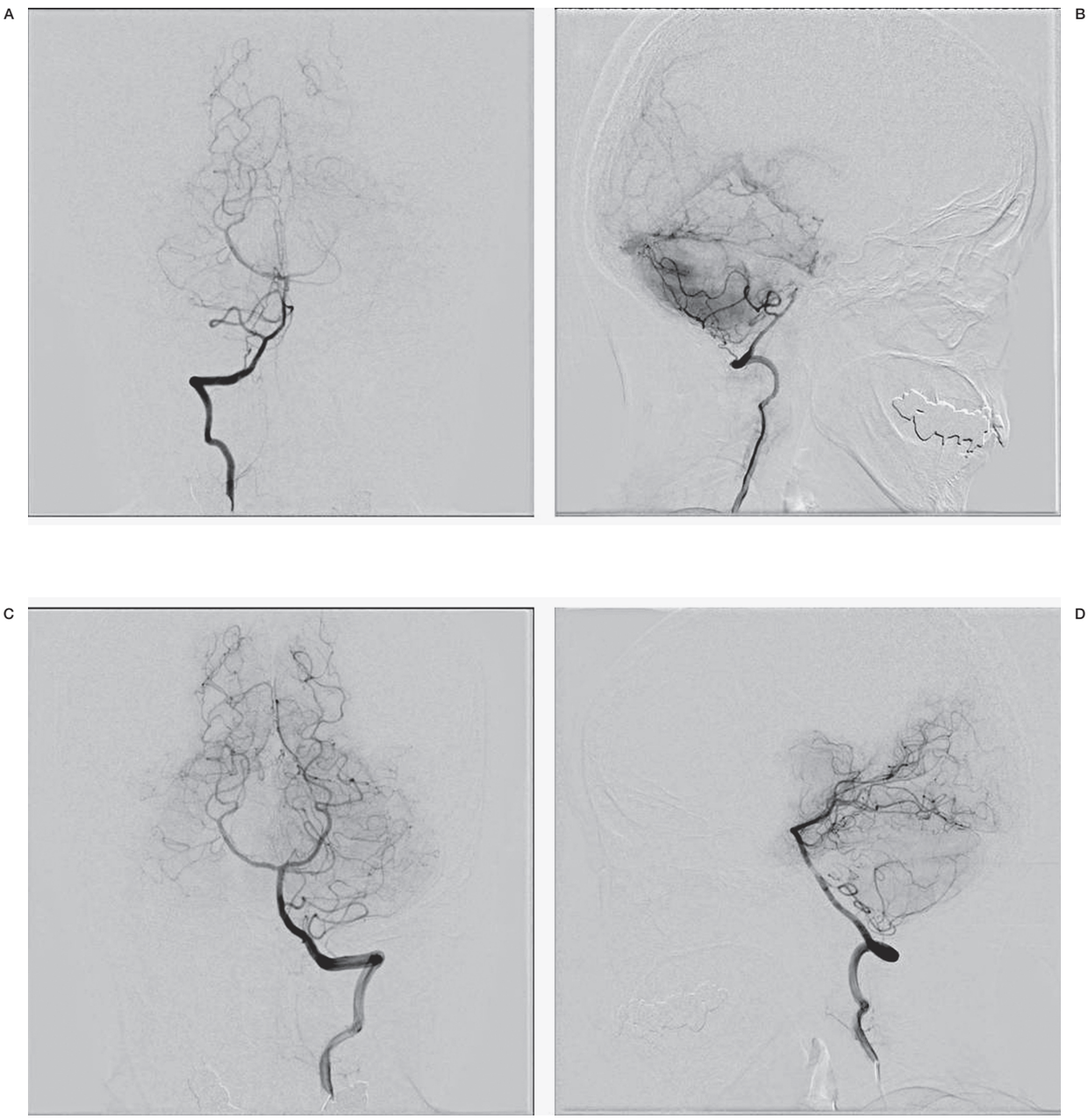

Figure 3 Right vertebral angiograms [anteroposterior (A) and lateral (B) views] and left vertebral angiograms [anteroposterior (C) and lateral (D) views] revealing the absence of the right superior cerebellar artery and the anterior inferior cerebellar artery.

bellar artery (AICA). The neck of the aneurysm was 4.3 mm in diameter, and the dome of the aneurysm projected superiorly (Figure 2). Bilateral vertebral angiograms demonstrated absence of the right SCA and AICA (Figure 3). Therefore, we planned intra-aneurysmal coil embolization using a double-balloon remodeling technique to preserve both the ICA and the PTA variant.

The patient was pretreated for seven days with 75 mg clopidogrel and 100 mg aspirin per day. A 6-Fr Shuttle sheath (Cook Medical, Indi-

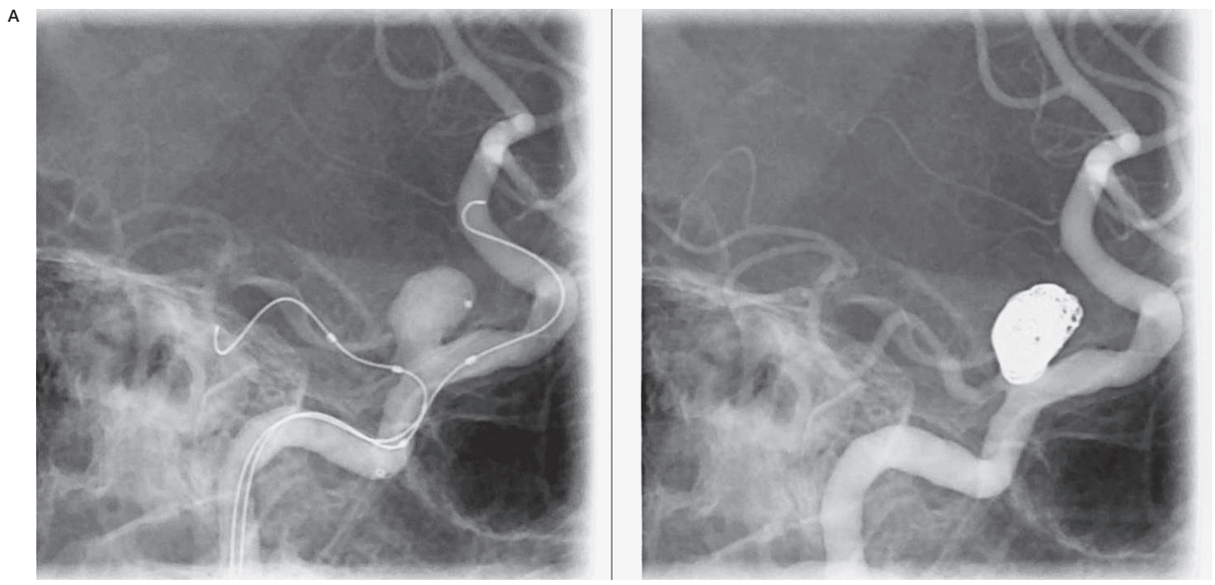

Figure 4 A) Lateral projections of the working roadmap demonstrating the HyperGlide™ balloon (eV3 Endovascular Inc., Irvine, CA, USA) in the right internal carotid artery and HyperForm™ balloon (eV3 Endovascular Inc.) in the primitive persistent trigeminal artery. B) Postoperative vertebral angiogram revealing almost total occlusion of the aneurysm and preservation of the primitive trigeminal artery variant.

anapolis, IN, USA) was placed in the right ICA under general anesthesia. Intravenous anticoagulation was induced with a 5000-U heparin bolus, and activated clotting time was maintained at approximately 300 s. A 4 × 10 mm HyperGlide balloon (eV3 Endovascular Inc., Irvine, CA, USA) was navigated into the right ICA and positioned across the neck of the aneurysm. Because it was impossible to navigate a second HyperForm balloon (eV3 Endovascular Inc.) into the right PTA variant, an Excelsior SL-10 (Boston Scientific, Natick, MA, USA) microcatheter was navigated into the PTA variant, and the HyperForm balloon was exchanged using a 300-cm X-Celerator™ exchange wire (eV3). The Excelsior SL-10 microcatheter was then navigated into the aneurysm sac. Both balloons were simultaneously inflated when each coil was placed. Balloon deflations were performed under blank fluoroscopic roadmap control to ensure that the coil loops did not prolapse into the ICA and the PTA variant. A total of eight coils (87 cm) were placed into the aneurysmal sac to completely embolize the aneurysm. The flow in both the ICA and the PTA variant was preserved (Figure 4).

The patient's postoperative course was uneventful, and she returned home without neurological deficits four days after treatment. Follow-up MRA obtained approximately one year after coil embolization revealed almost complete occlusion of the aneurysm, and follow-up skull roentgenography revealed no coil compaction. Her chronic headache did not change after endovascular treatment.

Discussion

PTA is the most common connection among the persistent embryonic vascular anastomoses connecting the developing carotid arteries and the longitudinal neural arteries. It connects the cavernous segment of the ICA with the BA. The PTA variants course along the trigeminal nerve without joining the BA and directly supply the cerebellum, eventually terminating as the cerebellar artery. Nishio et al. reviewed 67 PTA variant cases and reported that 71.6% PTA variants connected with the AICA, 28.4% with the SCA, and 18.0% with the posterior inferior cerebral artery [13]. The PTA variants are classified as lateral or medial depending on their course. The lateral type runs lateral to the dorsum sella, and the medial type takes a middle course through or over the dorsal sella [4]. In our case, the right PTA connected with the right SCA and AICA, and was thus classified as a lateral type.

The presence of an embryonic vessel persist-

ing into adult life is indicative of disturbed cerebrovascular development. Therefore, a PTA variant is frequently associated with other vascular abnormalities. A review of 67 PTA variant cases determined 22 aneurysms in 15 cases [13]. Most of the associated aneurysms were observed at the circle of Willis; in this review, only four cases were associated with an aneurysm arising from the junction of the ICA and the PTA variant, and the PTA variant trunk. To date, only six cases of treated PTA variant cerebral aneurysms have been documented, and aneurysms of the PTA variant itself are rare [11-16].

In these six treated cases, the aneurysms originated at the junction of the ICA and the PTA variant in three cases, and three cases presented with PTA variant trunks. Two cases were surgically clipped [12,15], two were treated by coil embolization [13,14], and two underwent parent artery occlusions [11,16]. The PTA and PTA variants are located deep and close to the cranial nerve and perforating vessels, making the surgical approach very difficult. We performed endovascular coil embolization in our case. Flow preservation in the PTA variant is essential in patients undergoing endovascular treatment because insufficient flow in the main trunk of the PTA variant compromises the circulation of the SCA, AICA, and perforating arteries to the brain stem and may induce dangerous post-treatment sequelae [17-20].

The balloon remodeling technique facilitates the endovascular treatment of wide-necked intracranial aneurysms [21-23]. Moreover, the modified double-balloon remodeling technique has been demonstrated to be useful in patients with aneurysms proximal to the circle of Willis [24,25]. Recently, stent-assisted coil embolization has been widely used for wide-necked aneurysms. In our case, coil embolization using conventional single-balloon and stent-assisted techniques was considered difficult because the PTA variant branched from the base of the aneurysm.

With regard to PTA variant aneurysms, direct surgical treatment is an option but may cause damage to the cranial nerves passing through the cavernous sinus. Proximal obliteration of the feeding vessels poses a substantial risk of ischemia. We believe that endovascular occlusion of the aneurysm with the preservation of parent vessels is a safe and eligible method of treatment, and the double-balloon remodeling technique is effective for preserving both the ICA and the PTA variant.

Conclusion

The association of a PTA variant with an aneurysm is very rare. To our knowledge, this is the first description of the use of coil embolization using double-balloon remodeling to treat a PTA variant aneurysm. This technique permits complete embolization and reduces the risk of cerebral and cerebellar ischemia.

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